Global Journal of human-social science: b
Geography, Geo-Sciences, Environmental Science & Disaster Management
Volume 16 Issue 5 Version 1.0 Year 2016
Type: Double Blind Peer Reviewed International Research Journal
Publisher: Global Journals Inc. (USA)
Online ISSN: 2249-460x & Print ISSN: 0975-587X

Comparative Study of BRICS Countries on Renewable Energy

By Dr. Ashok Kurtkoti

Abstract- One of the greatest challenges mankind faces today is environmental pollution, which is seen as a major threat and can cause global warming. The major causes of pollution are energy, automobiles and electrical appliances. Approximately 40% of the pollution is caused by the energy sector. Reducing this kind of pollution has given opportunity to researcher to carry out research in natural sources of energy like water, wind, solar, bio-gas etc. This paper examines the requirement on energy consumption and the efforts of BRICS nations towards shifting to renewable energy. In addition, this paper conducts a comparative study of the electricity mix, energy consumption and carbon emissions that BRICS countries have carried out. This study reveals that the main reason in power production is the rise of renewable energy in India and Brazil and these countries have been active in shifting to renewable energy. Russia had not made any efforts, whereas South Africa was just getting involved. India had initiated trade deals with BRICS countries through 'Make India' for renewable energy products. Among BRICS countries, China had carried out maximum trades for renewable energy.

Keywords: *CO2 emissions, renewable energy, BRICS countries, thermal power plants, electricity mix, energy consumption.*

GJHSS-B Classification: *FOR Code: 660299p*

Strictly as per the compliance and regulations of:

Comparative Study of BRICS Countries on Renewable Energy

Dr. Ashok Kurtkoti

Abstract- One of the greatest challenges mankind faces today is environmental pollution, which is seen as a major threat and can cause global warming. The major causes of pollution are energy, automobiles and electrical appliances. Approximately 40% of the pollution is caused by the energy sector. Reducing this kind of pollution has given opportunity to researcher to carry out research in natural sources of energy like water, wind, solar, bio-gas etc. This paper examines the requirement on energy consumption and the efforts of BRICS nations towards shifting to renewable energy. In addition, this paper conducts a comparative study of the electricity mix, energy consumption and carbon emissions that BRICS countries have carried out. This study reveals that the main reason in power production is the rise of renewable energy in India and Brazil and these countries have been active in shifting to renewable energy. Russia had not made any efforts, whereas South Africa was just getting involved. India had initiated trade deals with BRICS countries through 'Make India' for renewable energy products. Among BRICS countries, China had carried out maximum trades for renewable energy.

Keywords: CO2 emissions, renewable energy, BRICS countries, thermal power plants, electricity mix, energy consumption.

I. Introduction

Every year, we feel the temperatures increase in comparison to the previous year due to global warming. The main reasons for global warming are increase in automobiles, electrical appliances and pollution caused by industries. The conventional way of power generation is thermal and nuclear power plants. Nuclear power plants are costly and have limitations. Due to heavy carbon emissions causing air pollution, there is a shift to cleaner sources of power generation such as solar, hydro and wind energy globally. Due to climate change targets set it is essential to reduce CO_2 emissions by reducing dependence on thermal power plants and shifting to renewable energy. In this paper, a brief comparative study of the electricity mix, energy consumption and carbon emissions of BRICS countries was carried out. Study was also carried out on India's initiative on trade deals with BRICS countries through 'Make in India' for renewable energy products.

a) Need for study of Renewable Energy Sector

The various methods of power generation are:

1. Thermal
2. Hydro-Electric
3. Nuclear.
4. Solar.
5. Wind Energy.
6. Bio-Gas.

Among the above methods of energy generation mix the dependence is on coal based thermal power plants in many countries. However coal based power plants are harmful to the environment and human life as these plants emit heavy carbon dioxide (CO_2) and they are one of main cause of pollution. Also as these thermal power plants have become old and proper maintenance is not carried out, they operate at very low efficiency. Nuclear power plants are costly. Globally, nuclear is not a preferred option due to problems in nuclear disposables and Chernobyl accidents. Germany has plans to decommission all their nuclear plants by 2025 and replace them with wind turbines solar, wind energy and bio-gas are clean source of energy and due protection of surrounding environment there is a need to either shift or go for renewable energy.

Key issues encountered in Energy Production and Consumption in BRICS countries

There are some key issues to be encountered in Energy Production and Consumption in BRICS countries are:

Balance of interests, transparency predictability of supply and demand area on top priority. Due to substantial increase in energy consumption and supply being restricted matching demand becomes very difficult task for power distribution companies in BRICS country. Also if excess electricity is produced it becomes a waste and electricity is to be supplied and consumed immediately and cannot be stored.

In BRICS countries the demand for electric supply is growing every year due to urbanization and industrialization. The BRICS countries need to share their knowledge and experience in the related areas of energy planning, production and promoting mutual energy cooperation.

BRICS countries should address the following priority areas to enhance their energy security.

1. Enhancing awareness of the needs of the energy – producing and energy- consuming counties.
2. Extending mutual support for diversification of energy supplies
3. Promoting universal access to energy.
4. Increasing energy efficiency.

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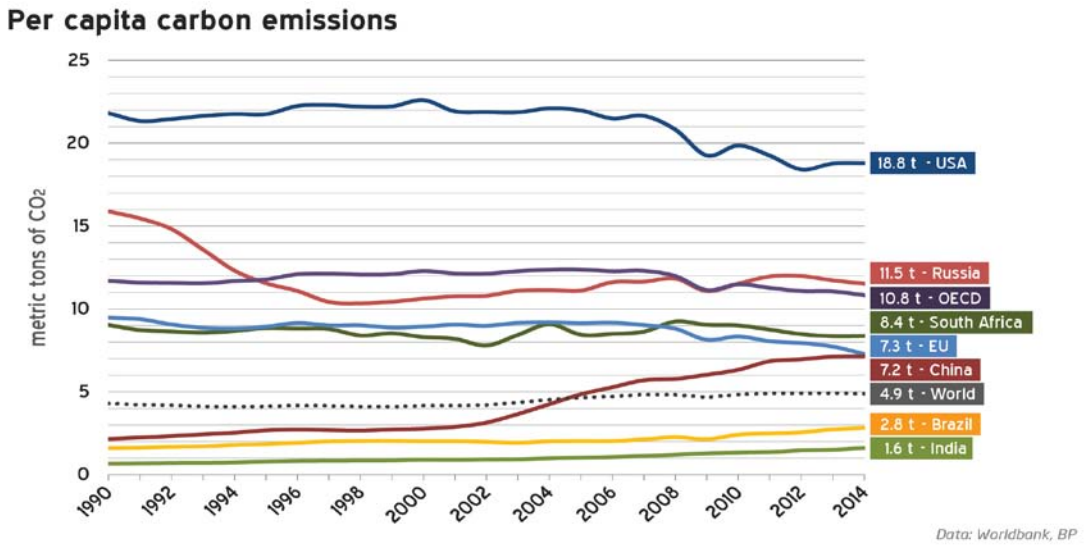
5. Introducing environmentally friendly technology of energy production, storage and consumption.
6. Promoting the use of renewable energy.
7. Improving the utilization of natural gas which is a clean source of energy.

To achieve the above goals BRICS countries should do the following

a. Promote efficient and environmentally friendly use of fossil fuels including proper cooperation in exploration.
b. Expand long term energy supplies.
c. Regular energy dialogue between the BRICS countries need to established so that long –term and medium -term strategies and energy security issues will be discussed.
d. BRICS countries to encourage cooperation for the investment in cleaner energy projects.
e. Encourage research on practical implementation of sustainable development in the BRICS countries, taking into account national interests.
f. Promoting universal access to power.
g. Joint development and sharing of knowledge on cleaner energy technology.
h. To strengthen public and private partnerships to stimulate energy efficient technology.
i. Exchange statistical data and forecast of development of national energy systems as well as information on best practices and regulatory framework.
j. To conduct research and development and studies on advance energy technologies in sectors which are mutually beneficial and will contribute in energy efficiencies[16]

Per capita carbon emissions is given in the following Figure 1



Source: www.greenpeace.de

Figure 1: Per capita carbon emissions

Globally all countries are realizing that coal-based thermal power generation is costly and also harmful to the environment and human health as it causes heavy pollution. The BRICS counties together contributed to about 38 percent of the global carbon emissions in 2014. The biggest share of 24 percent is China's, followed by India in the above study of carbon emissions of BRICS countries. Figure 1 show that only Brazil and India remain below world average in terms of per capita emissions. The reason being India's energy consumption is relatively low and Brazil uses hydro power and bio-fuels. Roughly the same emissions China emits as Europeans per person. The highest per capita carbon among BRICS countries is Russia, followed by South Africa. Considering aspect of reducing pollution has there is growing demand for shift to renewable energy.

The researcher had carried out SWOT Analysis of renewable energy sector and the same is indicated in Table 1-

Table 1: The Strengths, Weaknesses, Opportunities, Threats (SWOT) analysis of the Renewable Energy Sector

Strengths	Weaknesses
• Solution to reduce global warming	• Depends on vagaries of nature
• Effective utilization of natural resources	• Less efficient
• Pollution can be controlled	• Changing consumer's mind set is difficult
• The initial higher costs can be set off due to benefits of cleaner energy	• Farmers and rural consumers may get affected due to dams built
Opportunities	**Threats**
• Effective ways to reduce carbon emissions	• Due higher costs involved, the consumers are reluctant to shift
• To innovate new ways of energy generation	• Threats from social activist
• To save the earth from environmental pollution	
• To serve mankind	
• To save trees being cut	
• To market green products	

Source: 'Develop clean energy and save energy or perish[4].

II. Research Methodology

a) Objectives

1. To examine the various resources available in BRICS countries for electricity generation.
2. To study trade between India and BRICS countries for renewable energy products.
3. To carry out SWOT analysis of renewable energy sector.
4. To carry out Comparative study of BRICS Countries on Renewable Energy
5. To study the challenges faced by power sector in India

b) Scope of the study

Comparative study of BRICS Countries on Renewable Energy Major parameters considered for study were Energy generation mix, Major method of power generation, present methods of producing Renewable Energy with their emphasis on shifting to Renewable Energy for BRICS countries.

III. Method of Data Collection

Secondary data collected by visiting web sites and research articles/papers.

a) Limitation of the study

Except India it was not possible to gather data on challenges faced by power sector from other BRICS countries

b) Scope of the further research

Comparative study of the remaining countries on Renewable Energy can be carried to reduce pollution and global warming

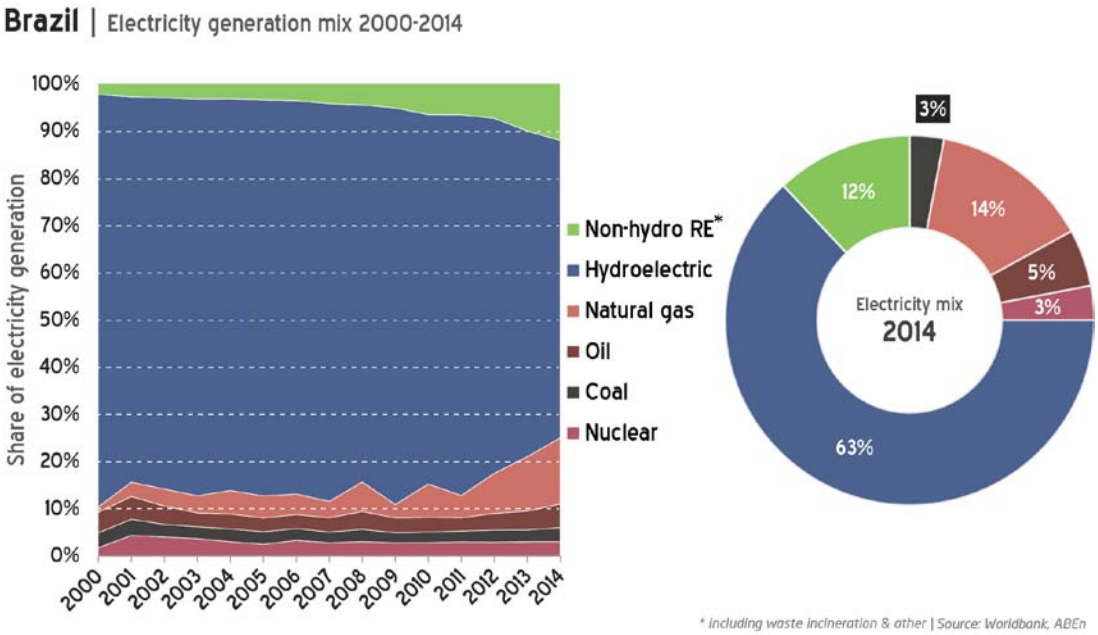
c) Comparative study of BRICS Countries on Renewable Energy

The researcher considered the following sequence for comparative study of BRICS Countries on Renewable Energy

1. Brazil
2. Russia.
3. India.
4. China
5. South Africa.

1. Brazil

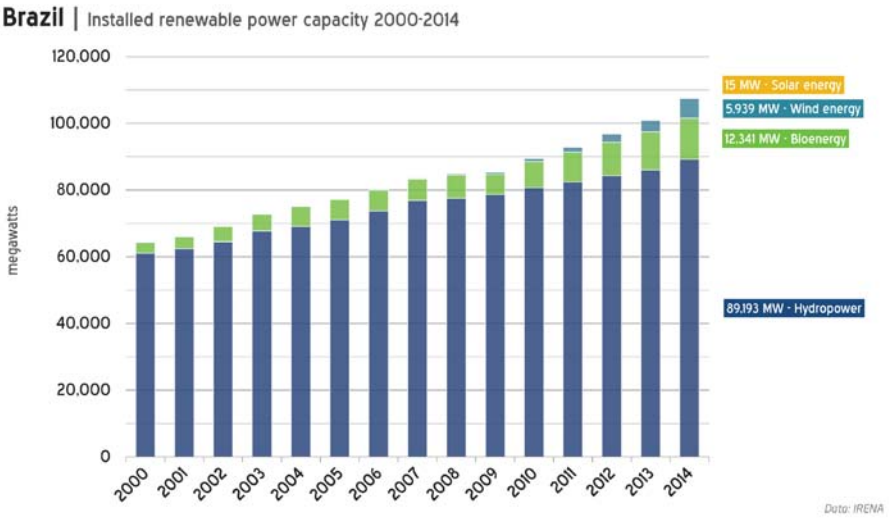
The following Figure 2 shows Brazil's electricity generation mix



Source: www.greenpeace.de

Figure 2: Brazil's electricity generation mix

The following Figure 3 shows the installed renewable capacity in Brazil



Source: www.greenpeace.de

Figure 3: The installed renewable capacity in Brazil

Key findings

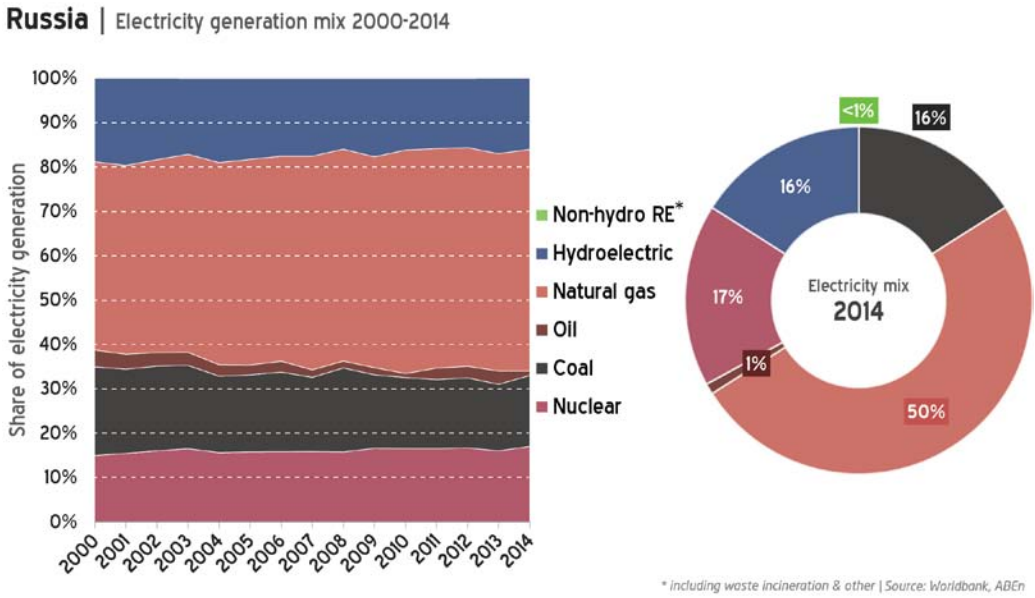
1. The main energy generation in Brazil was hydro power.
2. Brazil was focusing attention on building hydro power since2000.
3. In 2014, brazil built roughly 3 Giga watts of hydro power and therefore totaling to 84 Giga watts of hydro power
4. Brazil had shared the Itaipu dam hydroelectric facility with neighboring Paraguay. This was the second largest hydroelectric facility worldwide.
5. Hydro power plants are based on the natural resources and are clean source of energy. However there are great objections and protests by environmentalists on this issue. This type of power generation depends on rain fall which will be purely

depending on nature and carry a great amount of uncertainty. With environment destruction, the river water levels are decreasing year –by-year. From the farmer's point of view they lose employment and livelihood if the land is grabbed by the government for building of dams

6. A number of plants were in the middle of Amazon forest directly in and therefore local communities
7. The wind farms were installed in Brazil and the capacity of these wind farms was 6 Giga watts by end of 2014.
8. The wind farms may reach 16.5 Giga watts by end of 2019.
9. The ten year plan of Brazil's energy sector published in September 2015 was with focus on increasing solar plant capacity for 23.6 Giga watts by 2023. Brazil had installed only 15 megawatts solar plants by end of 2014.The solar power plants are dependent on heat spots and may be operative during part of the year and during monsoon and winter the solar plants will partially give output. Also the photo voltaic cells are costly and due to heavy taxation and duties the consumers are reluctant in using them.

2. Russia

The following Figure 4 shows Russia's electricity generation mix 2000 2014



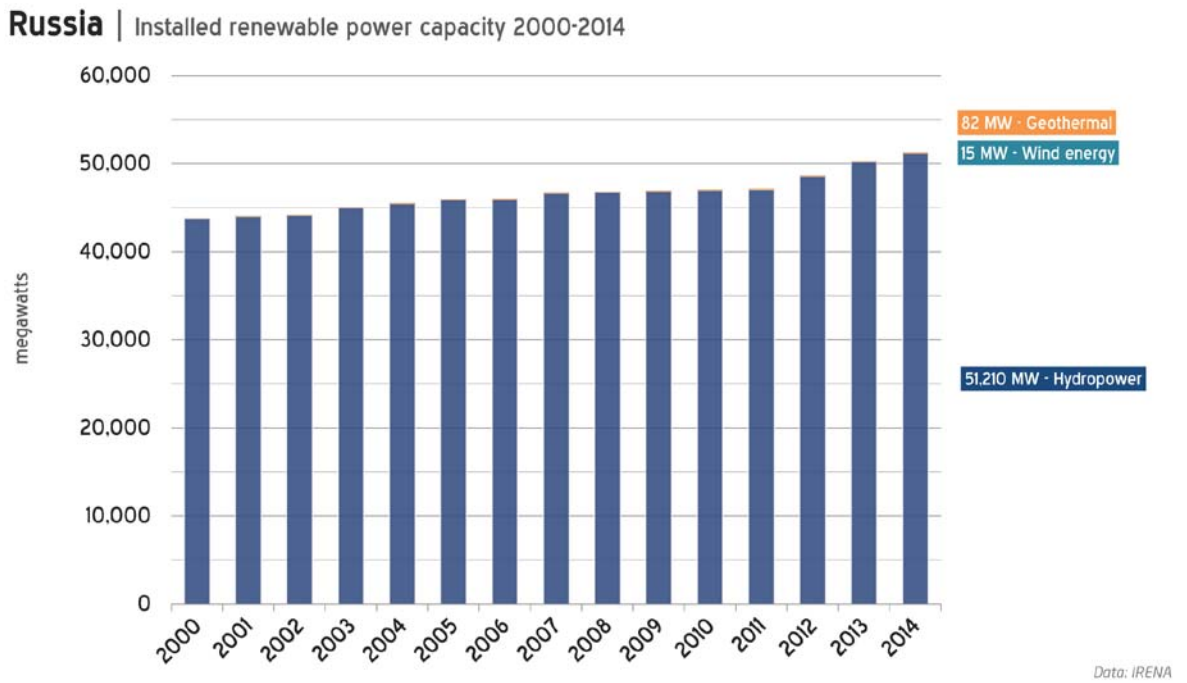
Source: www.greenpeace.de

Figure 4: Russia's electricity generation mix2000 2014

Key findings

1. Russia is a major exporter of oil, natural gas and coal to the world. Russia is a major exporter to Germany whom Russia the largest supplier of fossil fuels.
2. Russia is the largest in terms of land area and has large resources but has not concentrated on renewable but has focused their attention on producing the electricity by conventional means.
3. Carbon emissions dropped in Russia mainly due collapse in economy in 1990 and financial crisis in 2008.
4. 50 percent of electricity is generated by natural gas as a result the coal consumption has dropped slightly to 16 percent.
5. In terms of dominance of primary energy consumption, about16 percent of electricity is generated by conventional energy.
6. The share of nuclear had fallen to 1 percent from 17 percent of the total energy
7. The hydroelectric power accounted to about 16 percent.
8. The Coal based thermal power were amounting to 16 percent of electricity generation

The following Figure 5 shows the installed renewable capacity 2000 2014 in Russia

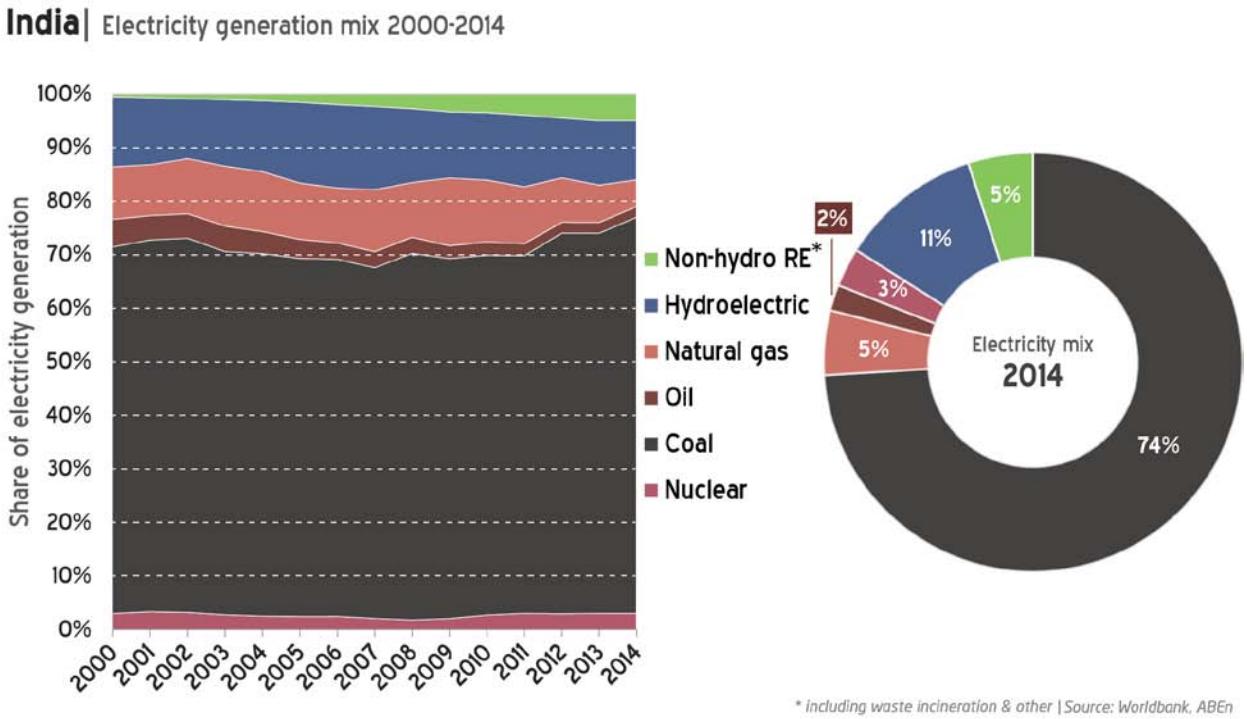


Source: www.greenpeace.de`

Figure 5: The installed renewable capacity in Russia2000 2014

4. India

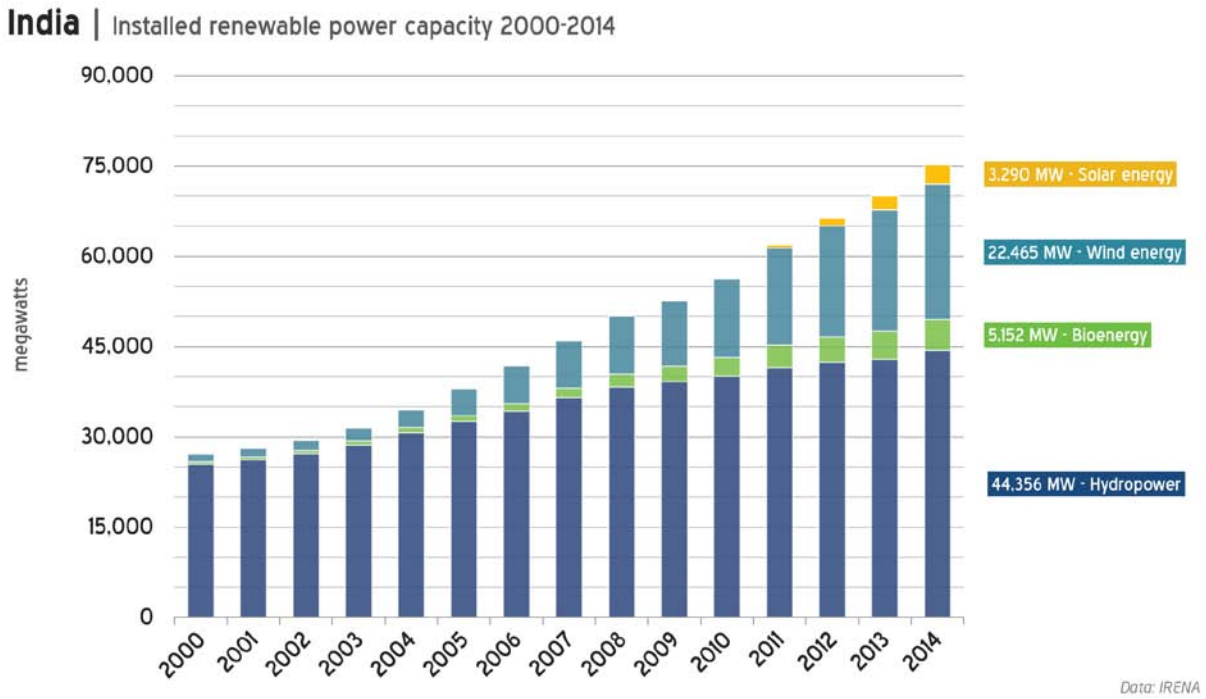
The following Figure 6 shows India's electricity generation mix 2000–2004



Source: www.greenpeace.de

Figure 6: India's electricity generation mix 2000 2004

The following Figure 7 shows India's renewable power capacity 2000–2014



Source: www.greenpeace.de

Figure7: India's renewable power capacity 2000–2014

d) The Power scenario in India

India had 306 GW of total generation capacity as of March 2015 and the government plans to add another 250 GW of total generation capacity by 2025.Frequent supply interruptions and poor power quality has driven many industries to develop captive generation plant having combined capacity of about 25,000 MW. Thakur, T, Chairman and Managing Director, Power Trading Corporation (PTC), foresee electricity demand growing 7.2 percent per annum, assuming GDP growth of 9 percent per annum and on an elasticity of 0.8 due to energy efficient technologies and other energy conservation and demand-side management measures. "Keeping this in view, energy generation will need to increase to a level of 1,470,000 million units (MU) by 2016–17 from a level of 1,038,000 MU in 2011–12 to service the increased demand", he calculated[1]. Presently, "Six millions Indians do not have access to electricity", stated Mr. Sethi, S, Principal Advisor (Energy), Planning Commission.[2]

e) Challenges faced by power sector in India

Following are some of the challenges faced by power sector in India-

1. Coal Shortage—presently about 74% of power generated is by thermal power plants. There is a severe coal shortage and it is a big political issue on assignment of coal blocks.
2. The demand for power is going up every year with urbanization and industrialization. There are hardly any power plants built up. The power plants require huge investment and the returns are after many years. This aspect makes investment very unattractive for private players and the investors are reluctant to make investments.
3. Presently many industries have their own captive power plants as the availability of power is uncertain .If no power supply is available industries, it can lead to labor unrest. These captive power plants are economically unviable for SMEs as the costs of operation will go up and they will not be able to compete in the market.
4. The distribution companies are making huge losses.
5. Majority of power plants are very old and running at almost 50% of capacity. Electricity boards have no money to modernize them.
6. Load shedding—one of the main reasons for power failure is load shedding which is result of inadequate power supply vis-a-vis power generation.
7. Price volatility—the supply tends to become constrained as generation and transmission reach their physical limit and electricity demand is very inelastic
8. Irrational tariffs- The tariff is fixed by State Electric Regulatory Committees and revision is possible only on the sanction from SERCs the State Government

have constantly interfered in tariff setting without SERCs subsidizing State Electricity Boards for the losses arising out of the State Government's desire to provide power at concessional rates to certain sectors like agriculture and domestic customers.

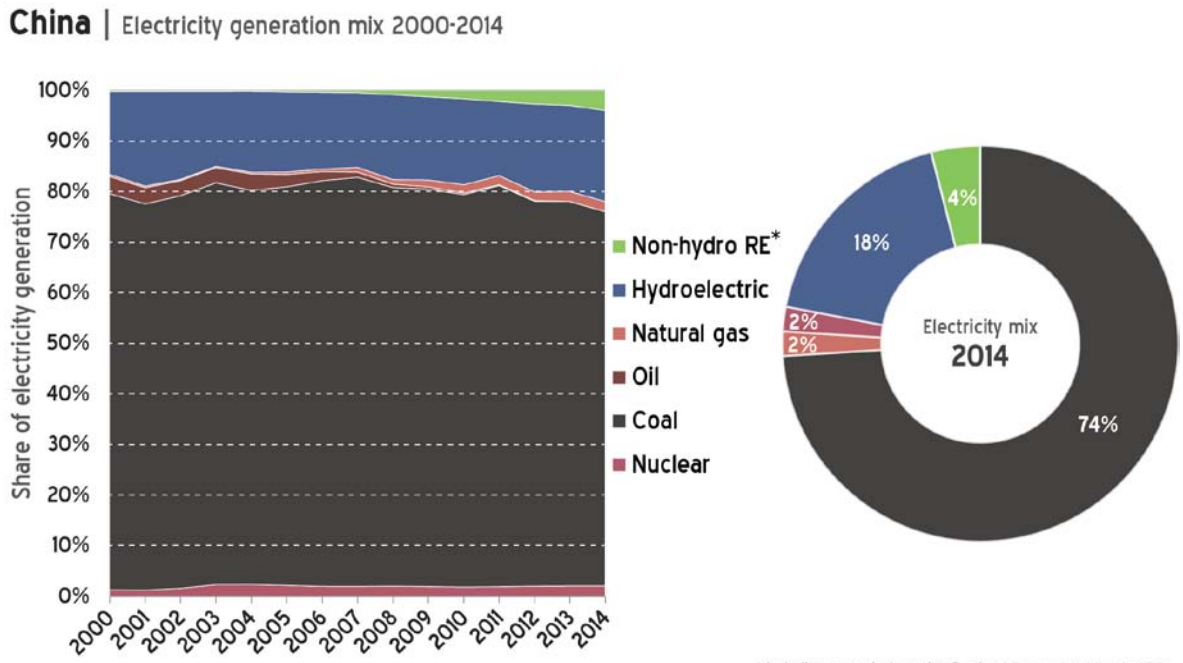
9. Corruption—the energy sector is a source of corruption. Asian Development Bank report stated, corruption in the sector is difficult to prove and determine because of the complex system and the multidimensional scale at which they operate in the development of a country.
10. Energy audit Energy audit is not carried out and there is a need for reducing excessive transmission and distribution (T & D) losses in the Indian Power Sector.
11. Inaccurate billing and metering The meters are easy to tamper. Many places the power is drawn without any meters and directly drawn from the pole.
12. Solar power is expensive. The consumers are not willing to shift to solar power due to higher cost.
13. The customers are not informed about non availability of power and are taken off guard. This hampers their regular planning and for continuous processes and top and bottom lines gets affected.

Key findings

1. The most common method used for power generation is by building thermal power plants. India had 306 GW of total generation capacity as of March 2015 However, the major drawback of thermal power generation type is environment pollution. According to world reports, 40% of air pollution is due to thermal energy. Another limitation of using coal is heavy reliance on imported coal in India due to inferior quality available in local market. Thermal plants have become old and need to modernize as present plants operate at50% less efficiency compared to the plants in other countries. By the end of 2014, coal based thermal plants account to about 74 percent of electricity generation mix.
2. Natural reserves in India is around 0.6% of world reserves. There is heavy reliance on import of liquefied natural gas which has become very costly. Even world natural gas production will reach its maximum limits in the next 15–20 years.
3. Nuclear Power: In India, the 'vision 2020, for nuclear energy foresees addition of 20.000 MW by 2020.New uranium mining sites in the north-east India are facing stiff resistance from local people. Even though it a known fact that India has a vast reserve of thorium, these thorium reactors are not proven. Also globally, nuclear is not a preferred option due to problems in nuclear disposables and Chernobyl accidents. Germany has plans to decommission all their nuclear plants by 2025 and replace them with wind turbines. With Fukushima blasts in Japan, has raised some red flags on India's nuclear programmes, including safety of multi –nuclear parks like Jaitapur India has a target of 63 GW by 2024.The problems faced in India is that planned nuclear are not completed in time. Nuclear Power of about 5 percent of electricity generation mix. Also nuclear power is more expensive as compared to coal or renewable energy. The council of Scientific and Industrial research (CSIR) estimated the cost of electricity from nuclear to be Rs 1/Kwh, compared to Rs 0.80/kwh form coal and Rs 0.80/Kwh from solar and Rs 0.60/Kwh from wind energy.[4]
4. Hydro Power: Hydro plants are based on the natural resources and are clean source of energy. However there are great objections and protests by environmentalists on this issue. With environment destruction, the river water levels are decreasing year –by-year. From the farmer's point of view they lose employment and livelihood if the land is grabbed by the government for building of dams.
5. With the above facts it high time to develop renewable power in India in the form of: a. Wind Energy. b. Small Hydro Power, c. Co-generation, Bagasse, d. Bio-power , e. Wind Energy and f. Solar Photovoltaic system.
6. Renewable sources like wind, solar photovoltaic, solar thermal and bio-energy sources like municipal solid and liquid waste, industrial waste, Bagasse and tapioca (bio-methanation) and small hydro plants have potential to develop in future. The clean energy technology action plan for Maharashtra, prepared by Pune-based World Institute of Sustainable Energy (Wise), has estimated that Maharashtra State has a potential to generate 57,000 MW to 2, 13,000 MW of renewable energy. Wise has recommended that Maharashtra make optimum use of its land and water resources to achieve low carbon and sustainable energy for future development.[3] The total target for 2022 is 175 Giga watts of renewable energy, 60 Giga watts will be wind power, 10Giga watts of bio mass and new hydro consist of about 5 Giga watts.

5. China

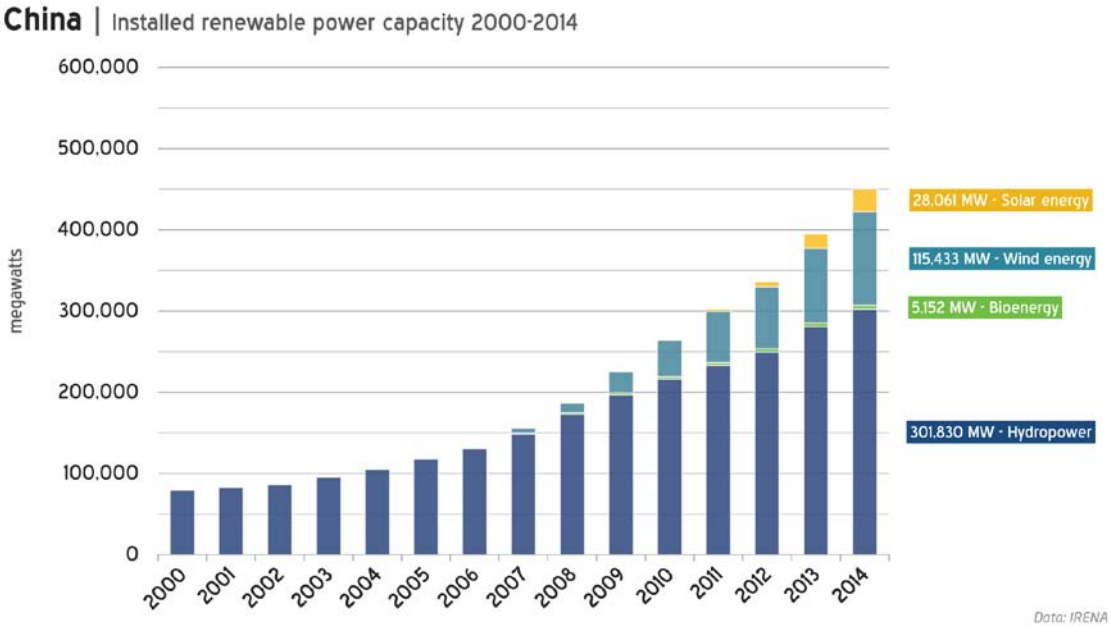
The following Figure 8 shows China's electricity generation mix 2000 2014



Source: www.greenpeace.de

Figure 8: China's electricity generation mix 2000 2014

The following Figure 9 shows India's renewable power capacity 2000–2014



Source: www.greenpeace.de

Figure 9: China's renewable power capacity 2000–2014

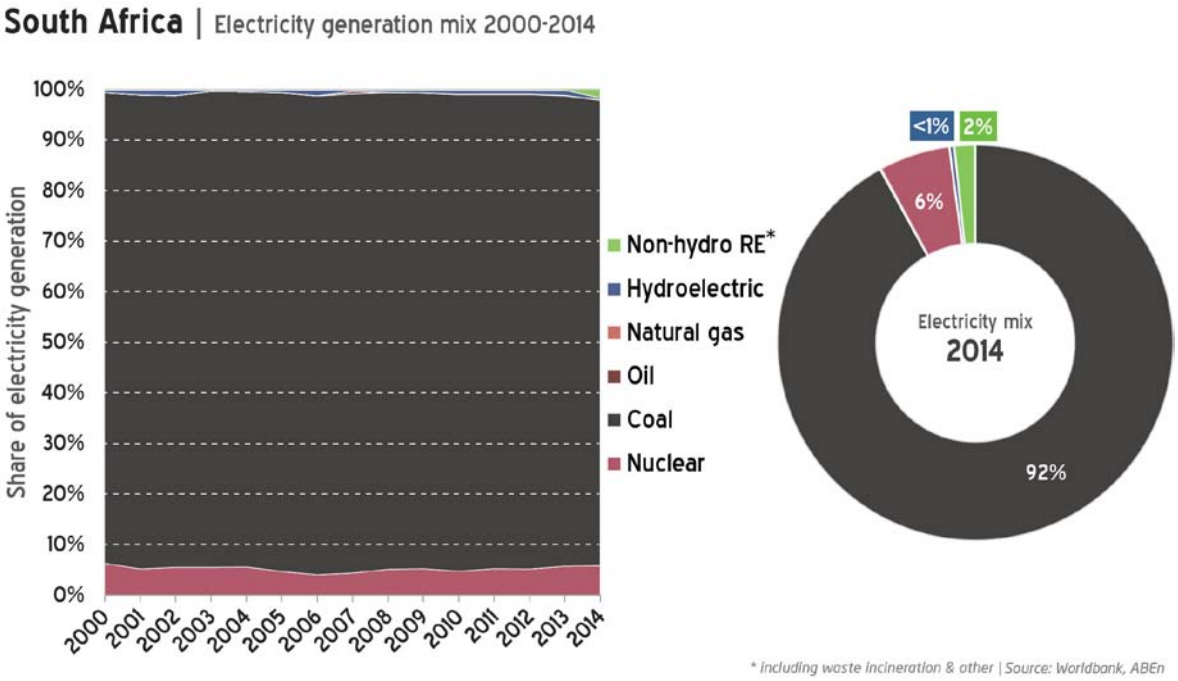
Key findings

1. China has built new coal fired power plants. From 2011 to 2015 China has added 190 GW of thermal generating capacity. Coal fired power plants account to about 74 percent of the electricity generation mix.

2. Due to air pollution from coal, Chinese officials are exploring to other renewable energy options seriously There wind and solar energy are still less compared to coal and hydro.

5. South Africa

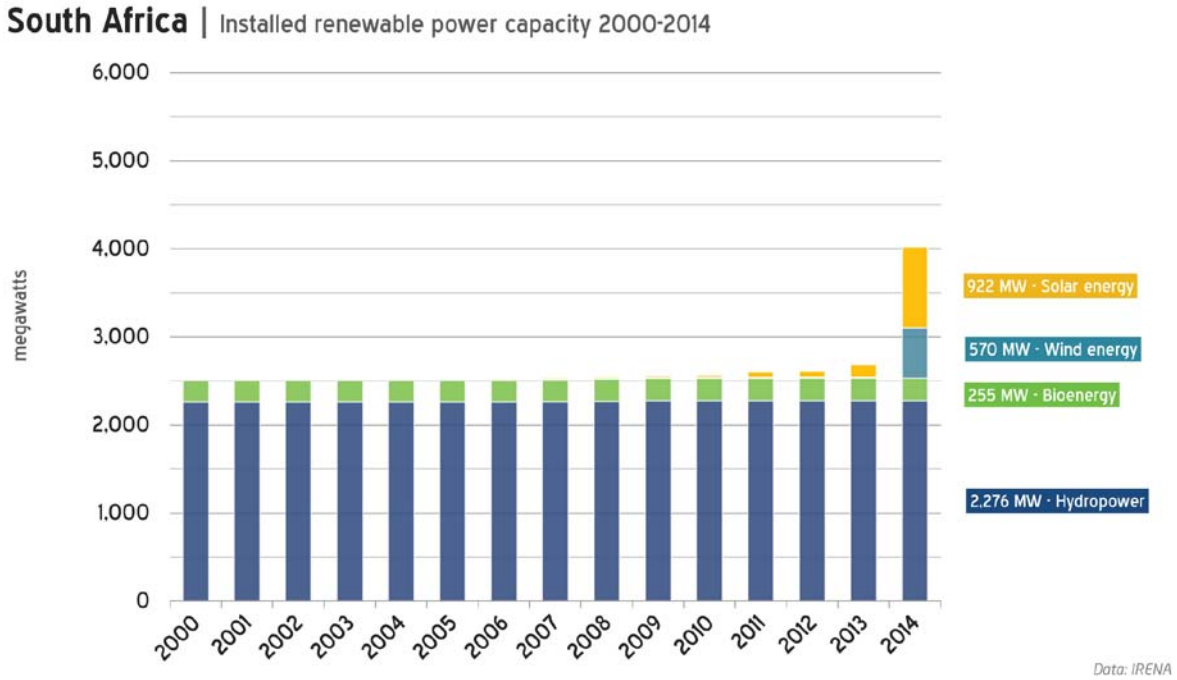
The following Figure 10 shows South Africa's electricity generations mix 2000 2014



Source: www.greenpeace.de

Figure 10: South Africa's electricity generations mix 2000 2014

The following Figure 11 shows South Africa's renewable power capacity 2000–2014



Source: www.greenpeace.de

Figure 11: South Africa's renewable power capacity 2000–2014

Key findings

1. South Africa depends heavily on coal based power plants as about 92 percent of electricity generating mix and this level has remained unchanged since last 15 years.
2. South African government planned for 9600 MW of nuclear power.
3. South Africa's per capita carbon emissions were found to be above level of European Union since 2008.
4. A study by an impendent consultancy from 2006 found that South Africa has a potential to get 75 percent of its electricity by mid-century.
5. In 2010, a report from UNEP found that South Africa has a potential to get 50 percent of its renewable electricity by 2030.
6. Since 2010 the cost of both solar and wind power have drastically come down in South Africa and have become cheaper than coal and nuclear power.
7. An impendent study by CSIR found that renewable energy from South Africa's first wind and solar projects created 4 billion and more financial benefits to South Africa than they cost during first six months of 2015.

f) Trade between India and BRICS Countries for Renewable Energy Products

With 'Make in India' imitative of Indian Government has given boost to trades between India and BRICS countries for renewable energy products

Key findings

a. Joint statement on 7thIndia-Brazil joint commission meeting and agreement on November 18- 19, 2015India expressed satisfaction with Brazil Investment in renewable energy. India apprised Brazil on the relaxed FDI policies and 'Make in India, initiative. India invited more investments from Brazil during this meeting. The ministers of both countries stressed the need for consolidation strategic partnership that strives for equity and transparency in the spheres of international finance, trade, climate change and sustainable development. Both country representatives acknowledge the complementarities in the mining sector and agreed to expedite signing of the MOU on cooperation in miming between their respective Geological Surveys. The Ministers of both countries emphasized the importance of increasing the share of renewable sources in the global mix. They expressed interest in the area of biomass, hydro-power, solar and wind energy technology.
b. In relation to sustainable growth BBC considered that the climate change is a real issue that comforts all countries and is a collective responsibility to contribute to mitigation efforts. On the path towards energy efficiency and the use of renewable sources of energy, the achievement of balance agreement on climate change and the use of renewable sources are equally important. The focus of all countries should be on adaptation, emission reduction, availability of finance, and transfer of technology at affordable costs. The energy sector should be based on three principles such as affordability, reliability and sustainable development. The energy should act like a catalyst to create sustainable development and economy there by attaining energy security in the BRICS region.
c. India will seek cooperation between BRICS countries on standards. Russia and Brazil are demanding a mechanism to link schemes such as Make in India, Digital India, and Smart City Mission with special emphasis on sectors like renewable energy and infrastructure.

Comparative study of BRICS countries based on the energy and green economy report with reference to renewable energy

The primary objective of the green economy working group was to address the challenges relating to energy security of supply, energy social equity and environment sustainability within BRICS countries, to achieve the goal of secure and sustainable energy for all.

This objective was to be achieved through the following

a. Promotion of Trade and Investment.
b. Promotion of Business Co-operation.
c. Technology transfer and Development.
d. Forming multilateral Parternerships to invest in Third Party Countries and multilateral business projects
e. Advisory role.

Key findings

a. The following table 2 shows the specific industries and sectors wanted to promote ,trade and have investment ties with the other BRICS countries and Africa

Table 2 : The specific industries and sectors wanted to promote ,trade and have investment ties with the other BRICS countries and Africa

Brazil	Russia	India	China	South Africa
Greater focus on sustainable fuels such as bio fuels	Focus on Hydro power, bi fuels, technology transfer on energy saving technologies, hydro power, bio fuels hydro power, bio fuels	Renewable like Solar, wind and bio energy	Renewable especially hydropower power	Renewable energy research & development, off grid solutions linked to renewable energy, hydro-power, manufacturing Solar PV' and Wind for local and exports

Source: www.brics.tpprf.ru/download.php?GET=6LPAY%2F81Bmw4jugd58EVrg%3D%3D

b. Among BRICS countries, China had carried out maximum trades for renewable energy[17]
c. The following table 3 shows the specific companies or corporations that had key and important promotion trade and investment ties with the other BRICS countries and Africa for renewable energy.

Table 3 : The specific companies or corporations that had key and important promotion trade and investment ties with the other BRICS countries and Africa for renewable energy products

Brazil	Russia	India	China	South Africa
No data available.	Renova Group who were involved in developing renewable energy in India and South Africa	Lanco Energy, Moserbaer India, Kiran Energy, Tata Power Solar, Welspun Energy, ACME Solar, IL&FS Energy, Thermax India, Mahindra Partners, Sunbourne Energy, Waaree Energy, sRRB Ener-gy, Clique energy, Suzlon India, wind world India, Global wind Power, Gamesa Wind turbines, Green Infra, Inox wind, NEPC India, Sindicatum Sustainable Resources, Yashwant Energy, Organic Recycling System and Grow diesel Ventures	Renova Group who were involved in developing renewable energy in India and South Africa	SAREC The South African Renewable Energy Council was an umbrella body to co ordinate and align the activities of its stakeholders in the renewable sector. A need had been identified for manufacturing facilities to setup in South Africa for Solar PV's and Wind for local and exports

Source: www.brics.tpprf.ru/download.php?GET=6LPAY%2F81Bmw4jugd58EVrg%3D%3D

Technology transfer and high technology Parternerships in the energy and green economy industry with the other BRICS countries

Brazil

Brazil had 40 years of experience in developing the largest ethanol programme in the world to substitute fossil fuels.

Russia

a. Russia established a working group bringing together investors, international organizations and multilateral development banks and the OECD to develop a dialogue on actions needed to foster financing for green and low carbon intensive technologies in BRICS countries.
b. Russia had a number of solutions on solar energy project development for India and South Africa.
c. Technology transfer for the energy saving technologies

India

India had joint ventures /investment in Process Technology Parternerships in:

i. PV manufacturing and wind turbine supply
ii. Process knowledge sharing and transfer under technology transfer agreement for the renewable products.
iii. Import of passive infrastructure for solar power projects.
iv. Alliance with Brazil for bio-ethanol production, the fermentation technology for production of 2nd generation bio fuels could be adopted in India.

India had also developed globally competitive manufacturing partnership and business in export of Wind Turbines and its components.

South Africa

South Africa renewable energy companies wanted to pursue with other BRICS countries as well as South African government on the following projects

1. Expansion of Inga and Grand Inga on the river of hydropower station in DRC and associated transmission infrastrure.
2. Mphanda Nkuwa construction of a 1500 MW hydro power station in Mozambique and Zambezi Basin.
3. Lesotho highlands water project phase 2 –water transfer programme to supply to Gauteng province in South Africa to generate 1200 MW of through a pump storage scheme.
4. Batoka Gorge hydro power –hydro electric plant with capacity of 1600 MW in Zambia and Zambezi Basin.

Source: brics.tpprf.ru/download.php?GET=6LPAY%2F81Bm-w4jugd58EVrg%3D%3D

The following table 4 shows future plans of BRICS countries to curb carbon emissions and share of renewable power by 2030

Table 4: Future plans of BRICS countries to curb carbon emissions and share of renewable power by 2030

Sr no	BRIC country	Brazil	Russia	India	China	South Africa
01	Climate change target	43% emissions cut by 2030 relative to 2005	25 to 30% reduction by 2030 relative to 1990	30–35 % increase in carbon emissions by 2030	Reducing carbon emissions by 60 to 65% relative to 2005	Reducing carbon emissions to 398-614 Mtoe
02	CO2 emissions compared to 1990	+113%	-33%S	+238%	+332%	+144%
03	Annual CO2 emissions per capita	9.1 tons (2012)	15.75 tons (2012)	2.33 tons (2012)	7.91 tons (2012)	8.8 tons (2012)
04	Share of renewable power in 2014	75 %	16%	16%	22%	02%

Source: www.greenpeace.de

Key findings

1. China has set very ambitious target of reducing carbon emissions by 60 to 65% relative to 2005. Brazil is already into renewable energy and has a moderate target 43% emission cut by 2030 relative to 2005.Surprisingly Russia has set low target of reducing carbon emissions.
2. CO2 emissions compared to 1990 China has maximum CO2emissions compared to 1990(+332) followed by India (+238%).AS both are populist countries and amount to almost one-third of the world's population.
3. India has least CO2 emissions per capita whereas has Russia maximumCO2 emissions per capita. This may be due to about 65% of population live in villages and usage of vehicles is less due to poor infrastructure and affordability. Russia maximum CO2 emissions per capita as the country are mainly into nuclear plants and space applications.
4. Brazil has tapped natural resources and share of renewable power in 2014 is maximum whereas South Africa has last used the natural resources amounting least Share of renewable power in 2014

IV. Recommendations

1. Brazil must tap its renewable energy potential
2. In Brazil, deforestation needs to be curtailed in the Amazon and Cerrado regions.
3. Russia should international renewable projects with neighboring countries like China, Mongolia, and Kazakhstan.
4. Russia to reorient subsidies from new oil and gas extraction as well as from nuclear power projects in favor of renewable energy.
5. Russia to develop ambitious targets in renewable energy.
6. In India about 45 percent of consumers do not have access to electricity. Indian government to ensure effective implementation of power projects to stick to a pledge to provide 24/7 electricity to all
7. Forests should be off-limits for coal mining in India. India must impose a restriction on coal mining in forest areas.
8. Indian prime minister said that his ambition is on efforts to ensure universal access for India's poor people. The state electricity boards and power distribution companies to ensure that Indian prime minister's ambition s are fulfilled. The state government must support in long term goal of phase out fossil fuels and nuclear energy by 2050
9. India has many hot spots and being tropical country, sun rays abundant are available for fixing solar panels on roof top. Indian government to incentivize and make it mandatory for all future buildings to use solar panels only
10. China to take proper steps to reduce dependence on coal consumption.

11. China to make concentrated efforts in implementing renewable energy projects in future.
12. The South African government must revise the country's electricity plan which was published in 2011(IPR 2010).
13. The current expansion of the coal sector in South Africa must be stopped. No further coal fired power plants to be built after Medupi and Kusile power plants.
14. The recent plan in South Africa ignores the massive advantage of natural resources available in the country.
15. Opportunities need to be created for manufacture of renewable energy in South Africa.
16. BRICS countries have shown keen interest in making FDI in India by signing MOUs for renewable energy products. It is recommended that all states should cooperate and ease out on doing business.
17. To achieve sustainable growth, BRICS countries need to promote value-added trade amongst BRICS countries by focusing their attention to cooperative investments in energy projects in BRICS countries.[16]

V. Conclusion

The electricity generation varies from country to country among BRICKS countries. There is heavy reliance on coal in India, China and South Africa. Brazil has good natural resources and has developed mainly on hydro plants as a source electricity generation. A political will and efforts are required by BRICS countries (barring Brazil) in shifting to renewable energy by tapping all natural resources. Indian government has invited manufacturing and trade initiative between BRICS for renewable products through 'Make in India'. China had carried out maximum trades for renewable energy.

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